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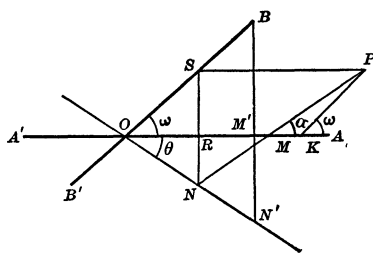
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$$(1) \quad y = KP = MP \sin \alpha / \sin \omega = b \sin \alpha.$$

Also  $NM = N'M' = a - b \sin \omega$ , and from the triangle  $ONM$ ,  $OM = NM (\sin \alpha \cot \theta + \cos \alpha)$ . From triangle  $ON'M'$ ,  $\cot \theta = OM'/N'M' = b \cos \omega / NM \therefore OM = b \sin \alpha \cos \omega + NM \cos \alpha = a \cos \alpha - b \sin (\omega - \alpha)$ . From triangle  $MKP$ ,  $MK = MP \sin (\omega - \alpha) / \sin \omega = b \sin (\omega - \alpha)$ . Hence,

$$(2) \quad x = OM + MK = a \cos \alpha.$$

Thus (1) and (2) are the desired (parametric) equations of the locus of  $P$ .

## II. REMARKS BY THE PROPOSER.

The part of the above proof following (1) can be shortened somewhat thus: Draw the straight line  $NRS$  perpendicular to  $OA$ , and join  $P$  to  $S$ . Then  $NM/NP = N'M'/N'B = NR/NS$  and hence  $RM$  is parallel to  $SP$  and also  $x = OK = SP$ . It now follows that  $x = PN \cos \alpha = a \cos \alpha$ .

The problem may also be treated geometrically as is done in Rouché and Comberousse, *Traité de Géométrie*, deuxième partie, 8e éd., 1912, pp. 341-345.

**332 (Mechanics) [October, 1916].** Proposed by E. E. MOOTS, University of Arizona.

A correct wording of this problem is given in 490 (Geometry) [May, 1916], a solution of which, by A. M. HARDING, was published in February, 1917.

**198 (Number Theory) [November, 1913; June, 1919].** Proposed by the late ARTEMAS MARTIN.

Prove that every even number is the sum of two prime numbers.

## NOTE BY R. C. ARCHIBALD, BROWN UNIVERSITY.

This is Goldbach's empirical theorem and the conjecture appears in a letter to Euler dated June 7, 1742 (*Corresp. Math. Phys.*, ed. Fuss, Vol. 1, 1843, p. 127). The first published statement of the theorem was by E. Waring in his *Meditationes Algebraicæ*, 1770, p. 217. E. Haussner verified the law for numbers up to 10000 (*Jahresbericht der Deutschen Math. Verein.*, Vol. 5, 1896, 62-66), and E. Maillet proved that every even number  $\leq 350000$  (or  $10^5$  or  $9 \cdot 10^5$ ) is, in default by at most 6 (or 8 or 14), the sum of two primes (*L'Intermédiaire des mathématiciens*, volume 12, 1905, p. 108). These notes are taken from L. E. Dickson's *History of the Theory of Numbers*, volume 1, 1918, where the complete history of the theorem may be found on pages 421-425. No proof of this theorem has yet been discovered.

**201 (Number Theory) [December, 1913; June, 1919].** Proposed by E. T. BELL, University of Washington.

Eisenstein proposed (*Crelle*, t. 27, p. 282) as the simplest of several problems: "In the expansion of

$$\frac{1 + z + z^2 + \cdots + z^{p-1}}{(1 - z)^{p-1}} - 1,$$

where  $p$  is prime, to show that the coefficients of the various powers of  $z$  are all divisible by  $p$ ."

## SOLUTION BY R. C. ARCHIBALD, BROWN UNIVERSITY.

$$\begin{aligned} \frac{1 + z + z^2 + \cdots + z^{p-1}}{(1 - z)^{p-1}} - 1 &= \frac{1 - z^p}{(1 - z)^p} - 1, \\ &= \left( pz - \frac{p(p-1)}{1 \cdot 2} z^2 + \cdots + \frac{p(p-1)}{1 \cdot 2} z^{p-2} - pz^{p-1} \right) (1 - z)^{-p}. \end{aligned}$$

Multiplying the first factor of this product by the second factor, expanded, we have the desired result. For, in each factor the coefficients are integers, and  $p$  is contained in every coefficient of the first factor.

Also solved by P. J. DA CUNHA, A. PELLETIER, and ELIJAH SWIFT.